Spectrometer-Emulsion Track Matching

Reinhard Schwienhorst

University of Minnesota

Long report
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Outline

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- Analysis
  - method
  - Matching to random tracks
  - further steps: scattering and vertexing
- Examples: neutrino interactions
- Magnetic moment candidate analysis
- Conclusions
- Outlook

Motivation

- Neutrino-electron interactions produce a single electron with momentum parallel to the beam
- Candidate events found in the data are suspected to be produced by out-of-time muons
- solution: match the spectrometer track to an emulsion track
  - determine if it a match can be found or
  - find a vertex or
  - check if another track scattered

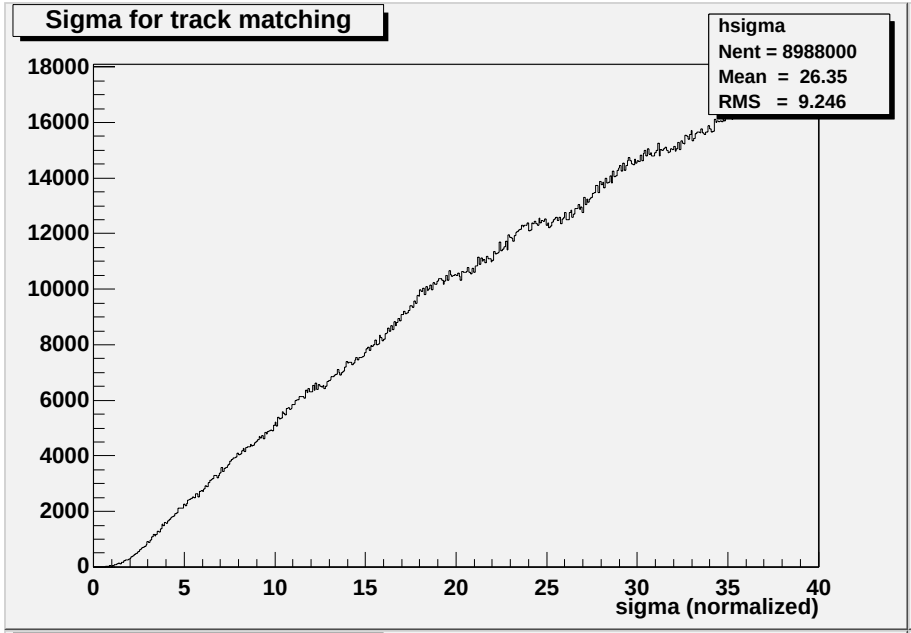
Analysis method

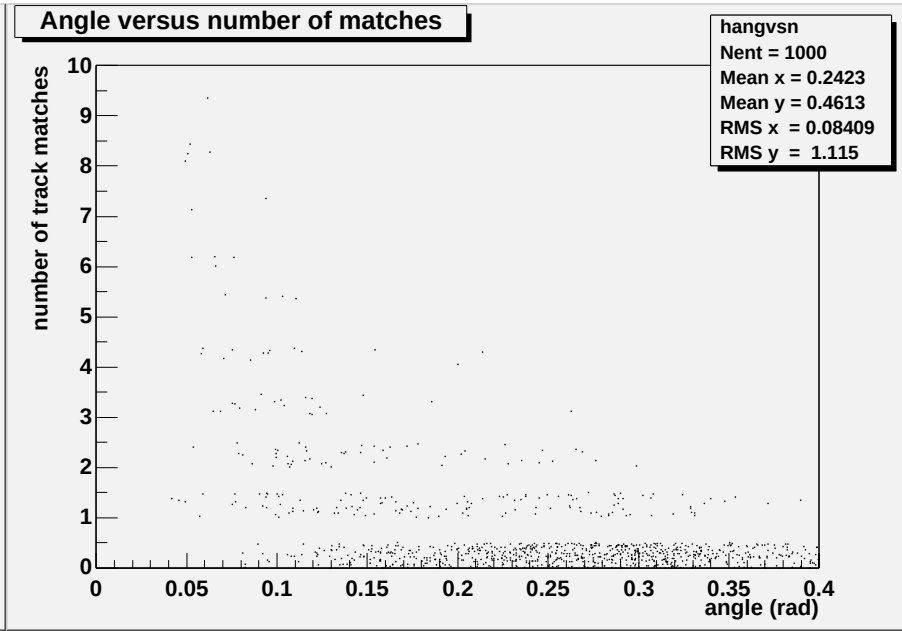
- Find starting emulsion tracks that could match the spectrometer track
  - everything within a 90% confidence interval ($\sigma<1.63$)

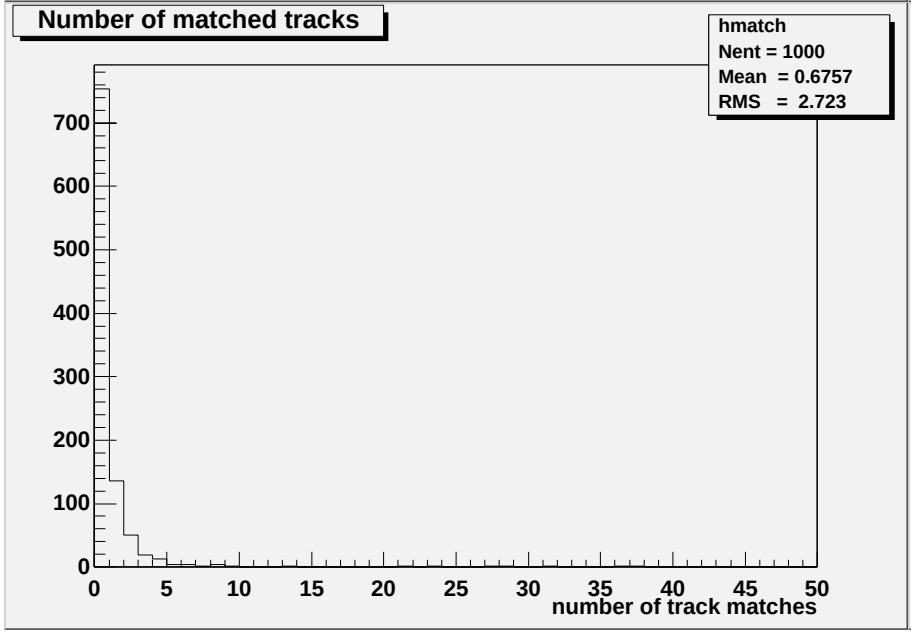
$$\sigma = \sqrt{\left(\frac{\Delta\text{pos}}{0.5\text{mm}}\right)^2 + \left(\frac{\Delta\text{angle}}{5\text{mrad}}\right)^2}$$

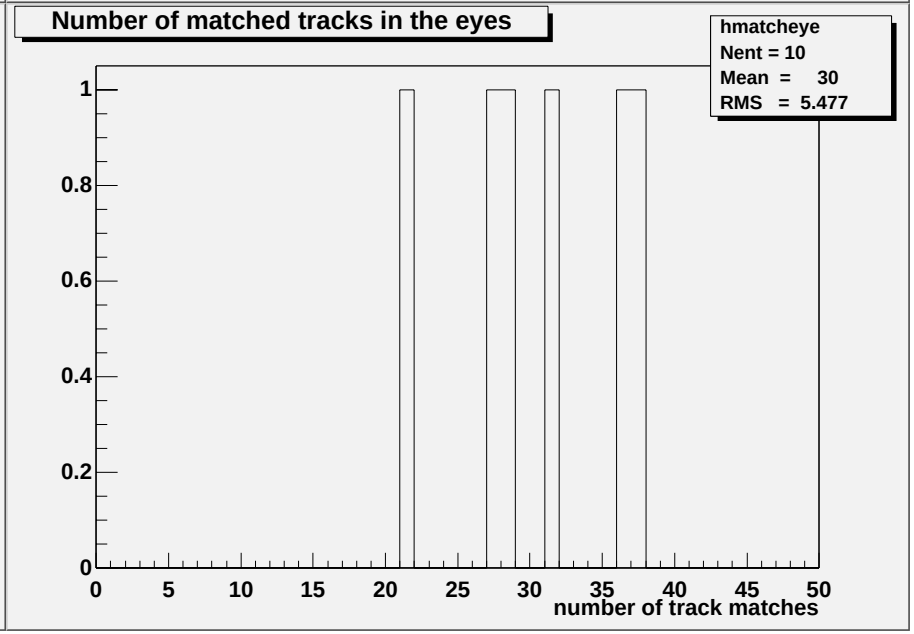
- Matching to random tracks:
  - expect 2 matches on average
  - expect >10 matches in the eyes

Matching to random tracks





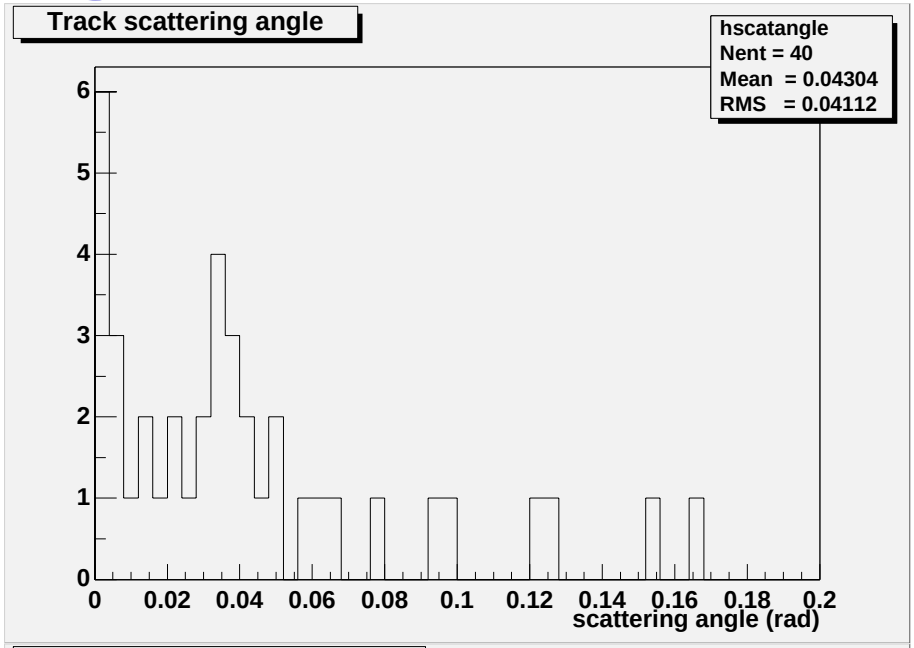


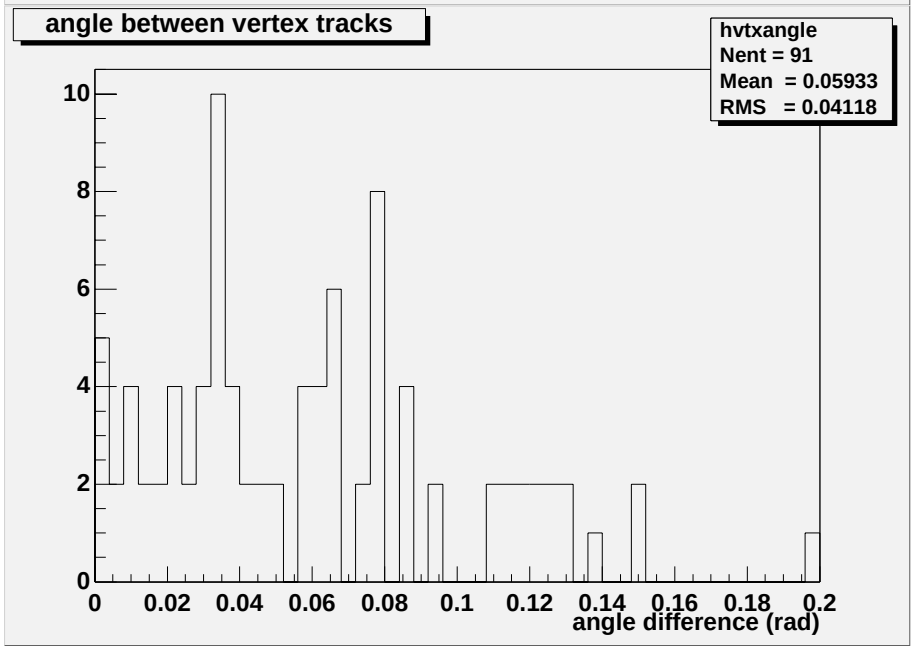


Further steps

- Check if another track scattered
  - true for 10% of all starting tracks
    - slightly higher in the eye region
- check if there is a vertex
  - true for 30% of all starting tracks
    - only 15% in the eye region
- check track pulseheight
  - large ($ph > ph_{\mu} + 3\sigma$) for 20% of the starting tracks
    - 40% in the eye region

Scattering and Vertex track angle

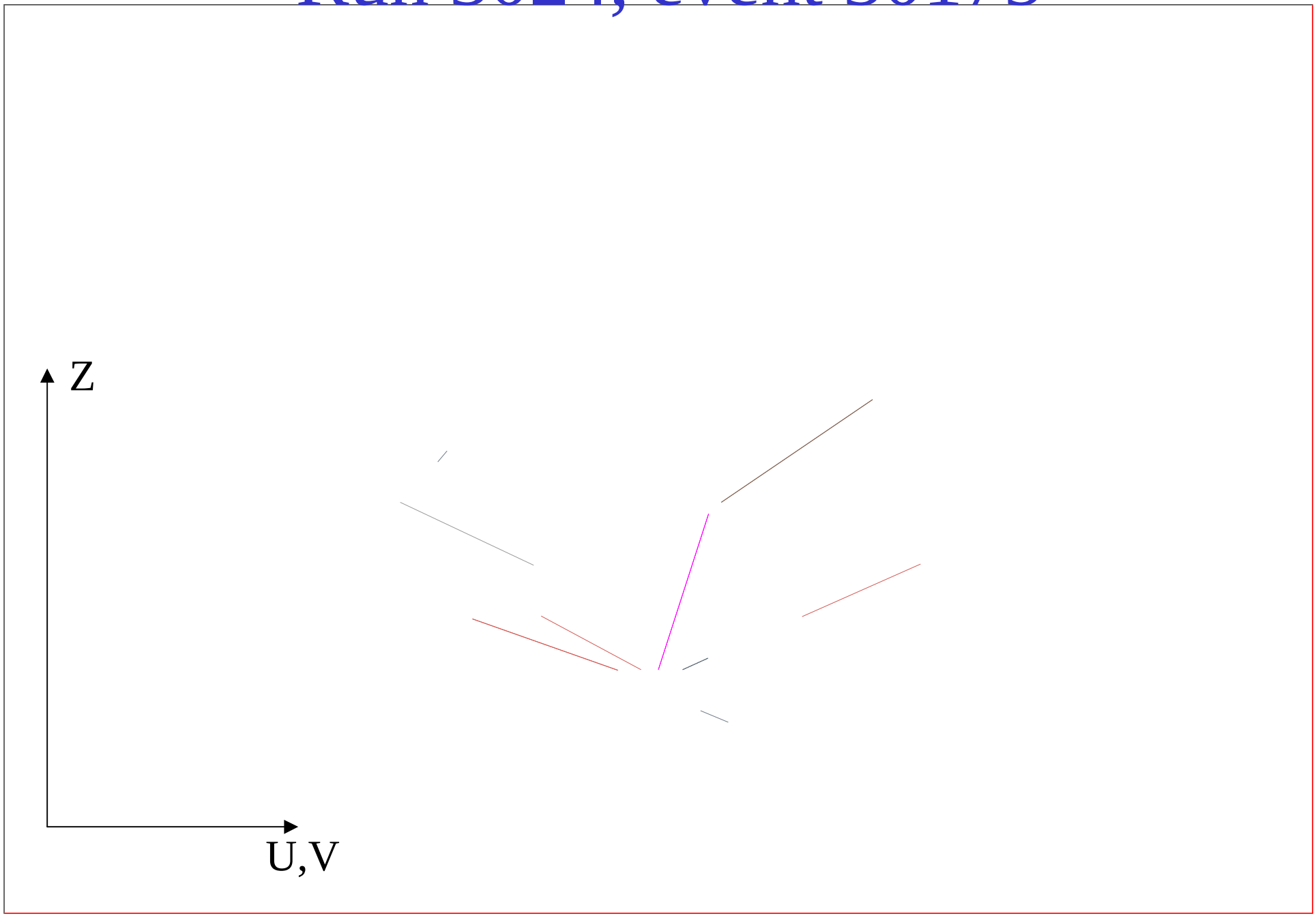




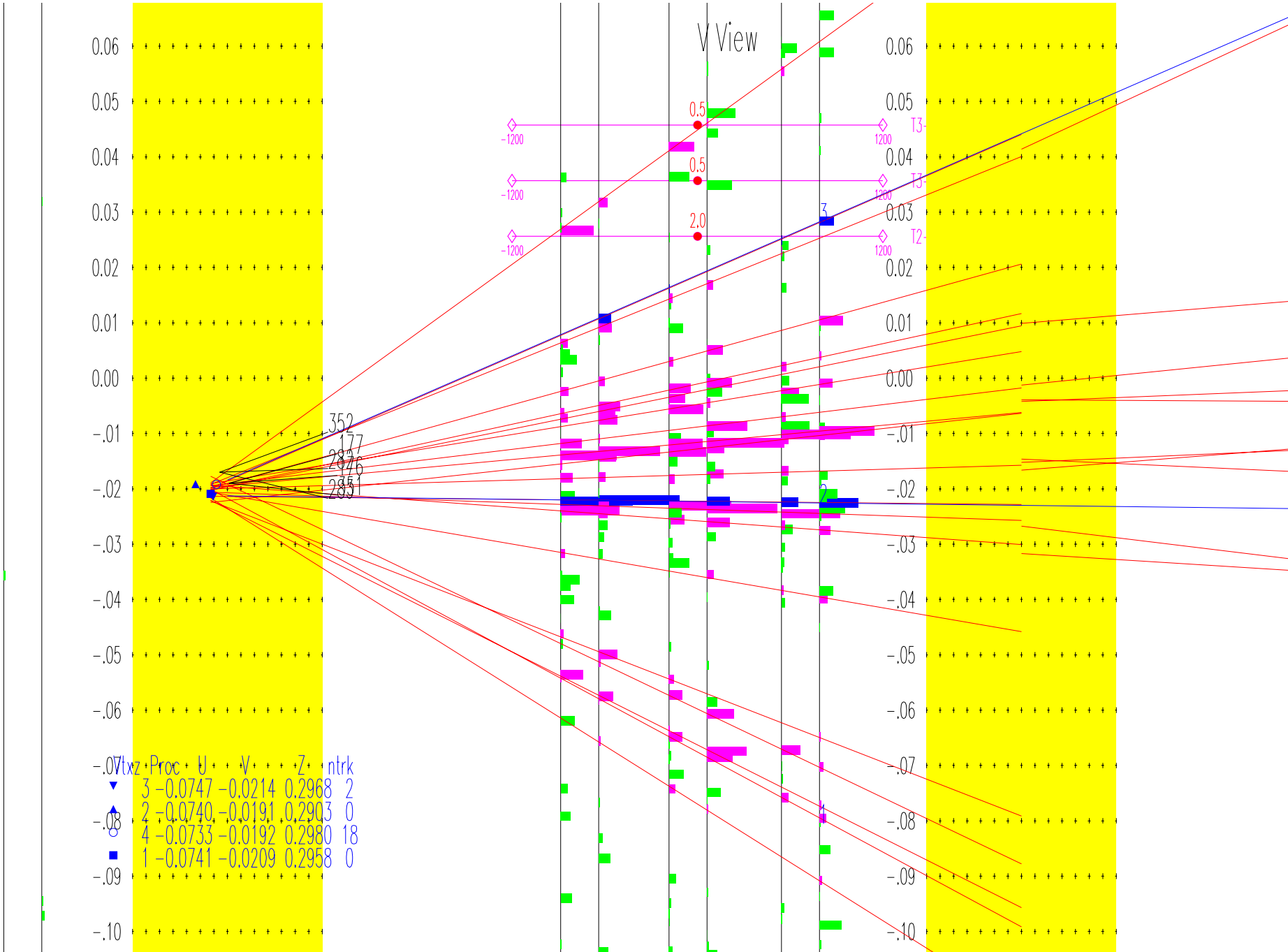
Check technique: tau event

- Event 3024_30175
- pick one nice spectrometer track
- correct angle using eyes
- match to emulsion tracks (2)
  - draw all matches
  - find other emulsion tracks that intersect matches (5)
    - draw these also
    - for each of them, check for a scatter (2)
      - draw each of the scattered tracks
  - find emulsion tracks upstream that could have produced a scatter (1)

Run 3024, event 30175



Run 3062, event 10903

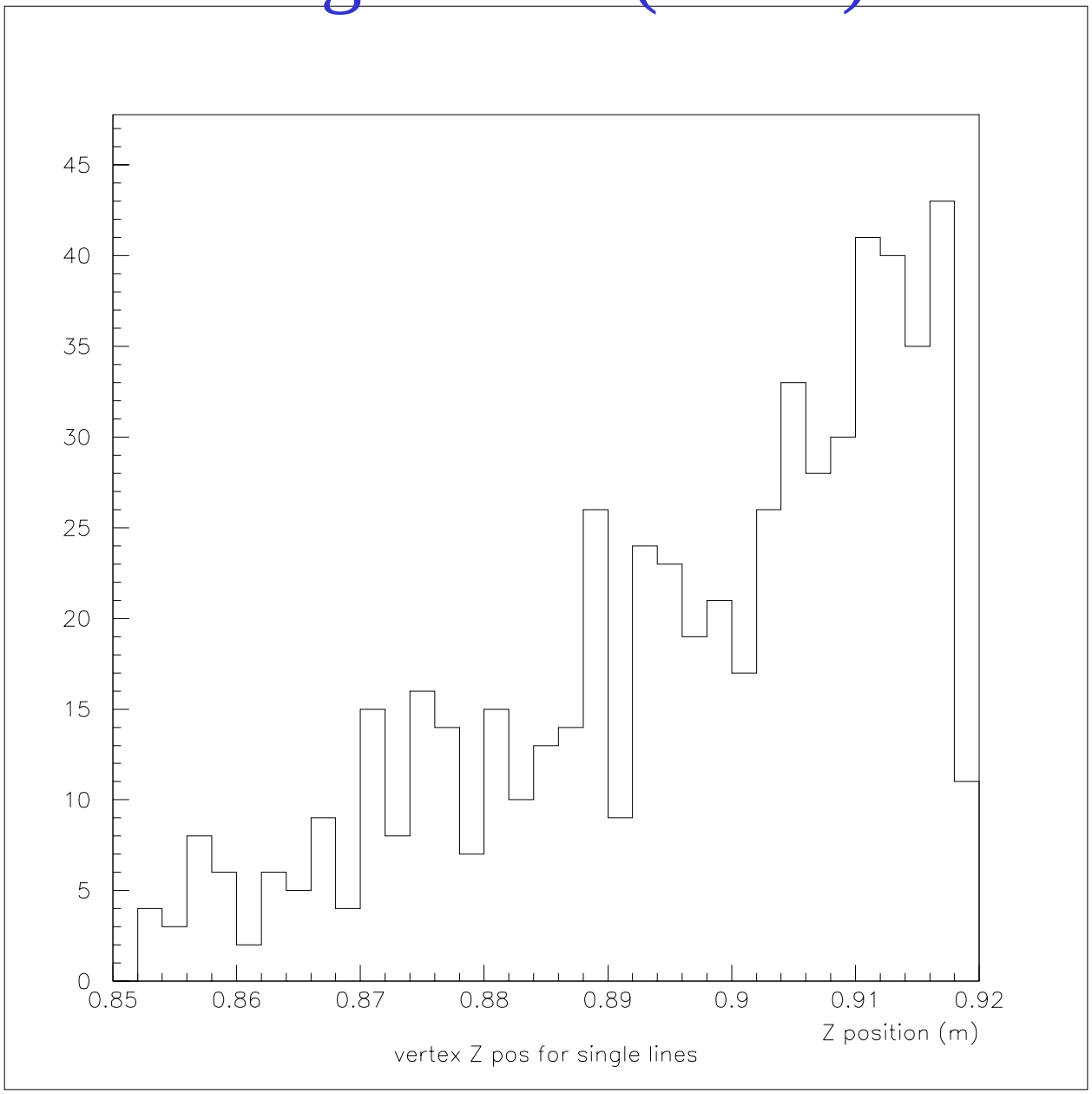


Run 3062, event 10903

Magnetic Moment candidate analysis

- 3 m-files
- single spectrometer track
- match to emulsion track in 90% confidence interval (CI)
  - 84, 14, 9 matches
- remove scattering, vertex, large pulseheight
  - 66, 10, 6 matches remain
- try also matching in 63% CI
  - 8, 1 (pl 22), 0 matches
- check start plate
  - randomly distributed in matched tracks
  - probability dependence on Z: see graph

Z-depencence of the probability for a single track (in B4)



Magnetic moment candidate emulsion analysis: Conclusions

- The track matching procedure
  - can be used outside the eyes
    - probability of a random match ≈50%
  - might be used at the edge of the eyes
    - ≈10 random matches
    - number can be reduced with more cuts
  - cannot be used in the eyes
    - ≈50 random matches
    - cuts reduce the number to ≈10
- The magnetic moment candidate tracks are in the center or at the edge of the eyes

Conclusions

- Spectrometer-to-emulsion track matching can be used to find the interaction vertex
- It can be used to find candidate tracks for a magnetic moment analysis
  - only if the track is not near the eye
- This analysis has been done with Root
  - the emulsion analysis tools exist

Outlook

- I will focus on the spectrometer analysis
  - obtain complete magnetic moment candidate event sample
- Emulsion analysis of candidate events will only be done if the single track is not in one of the eyes